This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

HARVARD UNIVERSITY.

LIBRARY

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY.

28396

GIFT OF

ALEXANDER AGASSIZ.

January 1, 1907.

Digitized by Google

28,396

MEMOIR

OF

JOSEPH HENRY.

BY

SIMON NEWCOMB.

READ BEFORE THE NATIONAL ACADEMY OF SCIENCES,

APRIL 21, 1880.

WASHINGTON, D. C.
JUDD & DETWEILER, PRINTERS
1903

Digitized by Google

Digitized by Google

Digitized by Google

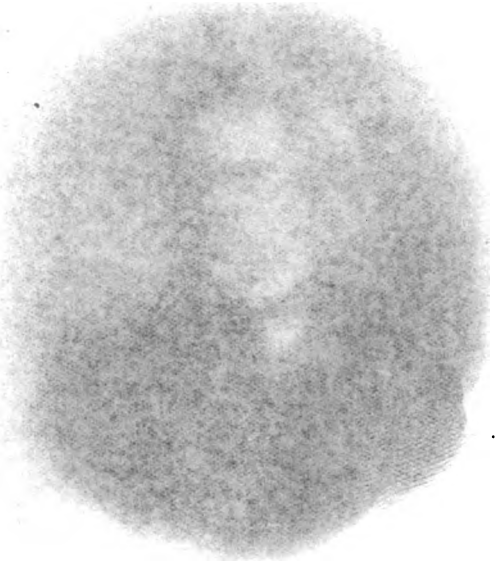
Prof. Joseph Henry.

ENGRAVED AND PRINTED
AT THE
BUREAU OF ENGRAVING & PRINTING,
U.S.
TREASURY DEPARTMENT.

Digitized by Google

JOSL

Digitized by Google



Digitized by Google

MEMOIR

OF

JOSEPH HENRY.

BY

SIMON NEWCOMB.

READ BEFORE THE NATIONAL ACADEMY OF SCIENCES,
APRIL 21, 1880.

Digitized by Google

Digitized by Google

BIOGRAPHICAL MEMOIR OF JOSEPH HENRY.

In presenting to the Academy the following notice of its late lamented President the writer feels that an apology is due for the imperfect manner in which he has been obliged to perform the duty assigned him. The very richness of the material has been a source of embarrassment. Few have any conception of the breadth of the field occupied by Professor Henry's researches, or of the number of scientific enterprises of which he was either the originator or the effective supporter. What, under the circumstances, could be said within a brief space to show what the world owes to him has already been so well said by others that it would be impracticable to make a really new presentation without writing a volume. The Philosophical Society of this city has issued two notices which together cover almost the whole ground that the writer feels competent to occupy. The one is a personal biography—the affectionate and eloquent tribute of an old and attached friend; the other an exhaustive analysis of his scientific labors by an honored member of the society well known for his philosophic acumen.* The Regents of the Smithsonian Institution made known their indebtedness to his administration in the memorial services held in his honor in the Halls of Congress.

Under these circumstances the only practicable course has seemed to be to give a condensed *résumé* of Professor Henry's life and works, by which any small occasional gaps in previous notices might be filled. That in doing this the writer may repeat much that has already been better said by others is a fault which he hopes the Academy will pardon in view of the difficulty of avoiding it.

The interest which, in the light of modern theories of heredity,

* The scientific work of Joseph Henry: Bulletin of the Philosophical Society of Washington, vol. II, p. 230; Smithsonian Miscellaneous Collections, vol. xxi, pp. 205–425; A Memorial of Joseph Henry, published by order of Congress, 1880.

Digitized by Google

attaches to the ancestry of men possessing uncommon intellectual powers would naturally lead us to desire a knowledge of Professor Henry's ancestors. We have, however, no sufficient historical data for gratifying any desire of this kind. Little more can be said than that his grand-parents were of Scottish origin, and landed in this country about the beginning of the revolutionary war. Of his father little is known, and that little does not enable us to explain why he had such a son. His mother was a woman of great refinement, intelligence, and strength of character, but of a delicate physical constitution. Like the mothers of many other great men, she was of deeply devotional character. She was a presbyterian of the old-fashioned Scottish stamp, and exacted from her children the strictest performance of religious duties.

The son Joseph was born in Albany, on the 17th of December, either 1797 or 1799.* The doubt respecting the year has not yet been decisively settled. At the age of seven years he left his paternal home and went to live with his grandmother at Galway, where he attended the district school for three years. At the age of ten he was placed in a store kept by a Mr. Broderick, and spent part of the day in business duties and part at school. This position he kept until the age of fifteen. During these early years his intellectual qualities were fully displayed, but in a direction totally different from that which they ultimately took. He was slender in person, not vigorous in health, with almost the delicate complexion and features of a girl. His favorite reading was books of romance. The lounging-place for the young villagers of an evening was around the stove in Mr. Broderick's store. Here young Henry, although the slenderest of the group, was the central figure, retailing to those around him the stories which he had read, or which his imagination suggested. He was of a highly imaginative turn of mind, and seemed to live in the ideal world of the fairies.

At the age of fifteen he returned to Albany, and, urged by his imaginative taste, joined a private dramatic company, of which

* This uncertainty appears to have resulted from the difficulty of deciphering the faded record of date in the old family bible. The writer's personal examination of the extant material leads him to favor the earlier date, which he believes to have been the one to which Henry himself was inclined.

Digitized by Google

he soon became the leading spirit. There was every prospect of his devoting himself to the stage when, at the age of sixteen, accident turned his mental activities into an entirely different direction. Being detained indoors by a slight indisposition, a friend loaned him a copy of Dr. Gregory's lectures on Experimental Philosophy, Astronomy, and Chemistry. He became intensely interested in the field of thought which this work opened to him. Here in the domain of nature were subjects of investigation far more worthy of attention than anything in the ideal world in which his imagination had hitherto roamed. He determined to make the knowledge of this newly opened domain the great object of his life, but did not confine himself to any narrow sphere. He devoted himself immediately, with great ardor, to study. During the three years following he was successively English teacher, pupil of various masters, and a student at the Albany Academy. At about eighteen years of age he was recommended by Dr. Beck to the position of private tutor in the family of the patroon. He found this situation to be a very pleasant one, and was treated with great consideration by the family of Mr. Van Rensselaer. His duties required only his morning hours, so that he could devote his entire afternoons to mathematical and physical studies. In the former he went so far as to read the *Mécanique Analytique* of La Grange.

His delicate constitution now suffered so much from confinement and study that he accepted an invitation to go on a surveying expedition to the western part of the State. In this work his constitution was completely restored, and he returned home with a health and vigor which never failed him during the remainder of his long and arduous life. Soon after his return he was elected a professor at the Albany Academy. Here a new field was opened to him. It is one of the most curious features in the intellectual history of our country that, after producing such a man as Franklin, it found no successor to him in the field of science for half a century after his scientific work was done. There had been without doubt plenty of professors of eminent attainments who amused themselves and instructed their pupils and the public by physical experiments. But in the department of electricity, that in which Franklin took so prominent a position, it may be doubted whether they enunciated a single generalization which will enter into the history

Digitized by Google

of the science. This interregnum closes with the researches now commenced by Professor Henry. His first published paper on the subject was read in 1827 before the Albany Institute, and is entitled, "On some modifications of the electro-magnetic apparatus." It consisted simply of a brief discussion of several forms of apparatus designed to exhibit the mutual action of the galvanic current and the magnet, but does not appear to comprise any discussions of new ideas. Two years later he published a topographical sketch of the State of New York, which also appeared in the Transactions of the Albany Institute. It comprises a brief sketch of the physical geography of the State with especial reference to the newly inaugurated canal system.

In 1831 he published in Silliman's Journal a paper on the development of great magnetic power in soft iron with a small galvanic element. This paper is in some sort a continuation of his first paper, the fundamental object of both being to show how the greatest development of magnetism could be obtained with the smallest battery. The ideas were suggested by the study of Schweigger's Galvanometer. He shows that in a piece of soft iron the magnetic power produced by the galvanic current may be greatly increased by increasing the number of coils. A still further improvement is made when, instead of passing a single coil between the two poles of the battery, a number of separate insulated wires are wound around the magnet, so that each shall form an independent connection. He was thus enabled with a battery of a single pair of small plates (4 by 6 inches) to form an electro-magnet which would lift a weight of 39 pounds. He also intimates that by winding a separate wire on each inch of the magnet a yet greater effect could be attained. This paper also contains the germ of the theory of electro-magnetic force, and of electrical resistance and quantity, though not developed in any generalized form. He explains that with one very long wire a combination of several plates must be used so as to obtain "projectile force," while when several larger wires are used the battery must consist of a single pair. A great number of experiments illustrative of the theory are described. With a battery having a single plate of zinc, of half a square foot of surface, he made a magnet lift a weight of 750 pounds,—more than thirty-five times its own weight.

In the same year, 1831, he describes a little machine for pro-

Digitized by Google

ducing continuous mechanical motion by magnetic attraction and repulsion. He considered the apparatus to be merely a philosophical toy, involving a principle which at some future time might be applied to a useful purpose.

In 1830, at the request of Professor Renwick, he commenced a series of observations to determine the magnetic intensity at Albany. This gave him occasion to investigate a subject of which the evidences had before been very conflicting, namely, the effect of the aurora upon the magnetism of the earth.

In 1831, April 19, at 6 p. m., a remarkable phenomenon was noticed, namely, an extraordinary increase in the number of vibrations of the needle, showing a corresponding increase in the magnetic intensity of the earth. Every precaution was taken that no local influence should affect the magnet, but the result was the same. About 9 o'clock in the evening a brilliant aurora commenced. The idea now occurred to him that it might be connected with the magnetic disturbance, and another observation of the magnet was therefore made. The result was the opposite of what had been anticipated, for instead of showing a continuous increase the intensity was now far below the average. An extended discussion of other results of the same sort is given, followed by an inquiry into the origin of the aurora.

The next important investigation in which Professor Henry appears is that which led to his being an independent discoverer of magneto-electricity. In the early experiments in this direction we have an interesting example of how a discovery may be long retarded through the want of correct theoretical notions. The idea entertained by the early experimenters of the present century seems to have been that since a galvanic current passing around a core of soft iron renders it magnetic, it may be expected that a magnet placed inside of a coil of wire will cause a current of electricity to pass through it. Accordingly, endeavors were made to produce this current by using powerful magnets. But since a continuous galvanic current can be employed to produce both heat and mechanical force, it follows that if it could be produced and kept up by simply inserting a permanent magnet in a coil of wire we should have a machine working without any supply of power. Since it can hardly be supposed that these experimenters would have hoped to realize the perpetual motion, the direction in which their efforts were prosecuted could have been

Digitized by Google

taken only through a failure to grasp the proper principles. These principles once apprehended, it would have been obvious that either the project of producing electricity from magnetism must be given up, or the production must be accompanied by motion or change in the magnet. The latter idea being grasped, success would at once have been assured. It happened, however, that the experiments pursued in a wrong direction necessitated this motion or change, because the magnet had to be moved to get inside the coil, or magnetism had to be produced in it in commencing the experiment, thus leading to a result.

In 1831, Faraday and Henry were independently working upon the problem. The former was entirely successful in showing how a momentary electric current could be produced by changes of magnetism in a soft iron body, or by other electrical currents, before Henry published anything of his work. No question, therefore, can attach to Faraday's claim to priority, and on the system sometimes adopted no other name than his would be mentioned in a history of the subject. But a more liberal principle now prevails, and the propriety of giving due credit to the independent investigator, though he may be behindhand in publishing, is very generally acknowledged. From Professor Henry's papers it would appear that he had actually reached a similar result before Faraday's work came to his knowledge. The magnet with which electricity was to be excited was the soft iron armature of his great galvanic magnet. A piece of copper wire thirty feet long was coiled around the middle of this armature and connected with a distant galvanometer. The great magnet being suddenly excited, the north end of the needle was deflected 30 degrees to the west, indicating a current of electricity in the helix surrounding the armature. The needle soon returned to its former position, and when the plates were withdrawn from the acid moved 20 degrees to the east. The conclusions of these experiments are now too familiar to need discussion. We can only regret that the American physicist did not immediately publish his first experiments.

In this same paper Professor Henry appears as the first discoverer of an important phenomenon of electricity now known as the self-induction of the current. A vivid spark is seen when a current through a long wire of considerable resistance is suddenly broken by withdrawing the wire from the cup of mercury

Digitized by Google

through which the connection is produced. The longer the conducting wire and the larger the plates of the battery, the more vivid the spark. He attributes it to the long wire becoming charged with electricity, which by its reaction on itself projects a spark when the connection is broken.* The same discovery was independently made two or three years later by Faraday, who does not appear to have noticed Henry's description of the phenomenon.

Shortly after this Professor Henry was called to the chair of natural philosophy in Princeton College. Although the duties of an American college professor seldom allow much time for original investigation, he soon resumed his electrical researches, and the first of a regular series was communicated to the American Philosophical Society in 1835. On February 6 of that year he continued the subject of the self-induction of the electric current with especial reference to the influence of a spiral conductor upon it. The series of experiments on this subject are very elaborate, but cannot be fully described without going into a series of minute details.

On November 2, 1838, he presented an extended paper on *Electro-Dynamic Induction*.† He states that since the discovery of magneto-electricity by Faraday in 1831 attention had been almost exclusively devoted to the induction of electricity from magnetism. He had therefore been engaged in reviewing and extending the purely electrical part of "Faraday's admirable discovery" in the direction indicated in the title.

Among the little known works of Professor Henry during this period are his researches upon solar radiation and the heat of the solar spots. In connection with his relative, Professor Alexander, he may be said to have commenced a branch of modern solar physics which has since grown to large proportions, by comparing the temperature of the solar spots with that of other parts of the photosphere. The first experiments were made on January 4, 1845. A very large spot was then visible upon the sun, the image of which was formed by a four-inch telescope upon a screen in a dark room. A thermopile was placed in such a position that the image of the spot and of the neighbor-

* *American Journal of Science*, Series I, volume xxii, 1832, page 408.

† *Transactions of the American Philosophical Society*, volume vi, page 308.

Digitized by Google

ing parts of the solar disk could be thrown upon it in quick succession. The result of observations extending through several days was that decidedly less heat was received from the spot than from the brilliant part of the photosphere. It is believed that it was these experiments which started Secchi on the brilliant investigations in solar physics which he carried on in subsequent years.

Among Professor Henry's latest electrical researches was his analysis of the dynamic phenomena of the Leyden jar. The one of his discoveries which he most often referred to in later years was that the discharge of a Leyden jar did not consist of a single restoration of the equilibrium, but of a rapid succession of librations back and forth, gradually diminishing to zero. This was proved by passing the discharge through a coil of wire containing needles of different degrees of magnetic force. After the discharge these needles were found to be magnetized in different directions, according to their size and hardness.

In one of his numerous communications presented to the Philosophical Society he appears as one of the inventors of the electro-chronograph. On May 30, 1843, he presented and read a communication on a new method of determining the velocity of projectiles. It was in its essential parts identical with that now generally adopted. It consisted, he says, in applying the instantaneous transmission of the electrical action to determine the time of the passage of the ball between two screens placed at a short distance from each other on the path of the projectile. For this purpose the observer is provided with a revolving cylinder, moved by clock-work at the rate of at least ten turns in a second, and of which the convex surface is divided into a hundred equal parts, each part therefore indicating in the revolution the thousandth part of a second. Close to the surface of this cylinder, which revolves horizontally, are placed two galvanometers, one at each extremity of a diameter; the needles of these being furnished at one end with a pen for making a dot with printer's ink on the revolving surface. In the appendix to the paper he proposes to dispense with the galvanometer and produce the marks by direct electro-magnetic action, as is now done in the familiar astronomical chronograph.

While at Princeton a number of researches in other branches of experimental physics were published. It is not however

Digitized by Google

necessary to describe them at length, because they are most exhaustively discussed in the memoir of Mr. Taylor before referred to. Whether they pertain to the most familiar phenomena of every-day life or the most complex combinations in the laboratory, they are all marked by the qualities of the author's mind,—acuteness in cross-examining nature, a clear appreciation of the logic of science, and an enthusiasm for truth irrespective of its utilitarian results. Reserving for the future some general remarks on the scope of Professor Henry's scientific work, the qualities which it displays, and its relation to the progress of our country, we may now pass to his connection with the Smithsonian Institution.

The origin of the Smithsonian Institution is so remarkable, and many features of its early history so instructive, that it must long continue to be a theme of interest to the historian of our intellectual development. The writer may therefore be excused for touching upon a threadbare subject by repeating the story of the origin and early difficulties of this establishment. He does so the more willingly because he believes some features connected with it have not been fully brought out.

James Smithson, a private English gentleman of fortune and scientific tastes, a chemist of sufficient note to be elected a Fellow of the Royal Society, led a comparatively retired life, and died, unmarried, in 1829. He does not seem to have left any near relatives except a nephew. On opening his will it was found to be short and simple. Except an annuity to his servant, he left the nephew, for his life, the whole income from his property, and the property itself to the nephew's children should he leave any. In case of the death of the nephew without leaving a child or children, the whole property was bequeathed "*to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men.*"

Probably few men have ever written a clause so well fitted as this to excite a curiosity which can never be gratified. The views and motives of the writer in making this provision are involved in impenetrable obscurity. The first idea to strike a reader would be that Smithson had some especially kindly feelings toward either the United States or its form of government. But no evidence of this has ever been discovered. He is not

Digitized by Google

known to have had the personal acquaintance of an American, and his tastes were supposed to have been aristocratic rather than democratic.

It would also have been supposed that the organization of an institution which was to carry his name down to posterity would have been a subject of long and careful thought, and of conversation with friends, and would have been prescribed in more definite language than that used in the will. Some note, some appended paper would certainly be found communicating his views. But nothing of the sort has ever come to light.

The next explanation to suggest itself would be that the death of his nephew without children was a contingency so remote that very little thought was given to what might happen in that event. But it is said that on the contrary Hungerford, the nephew, was unmarried and in infirm health, and that his death without children might naturally have been expected.

We thus have the curious spectacle of a retired English gentleman, probably unacquainted with a single American citizen, bequeathing the whole of his large fortune to our Government to found an establishment which was described in ten words, without a memorandum of any kind by which his intentions could be divined or the recipient of the gift guided in applying it.

Hungerford died in 1835. An amicable suit in chancery was instituted by our Government, through the Honorable Richard Rush as its agent, the defendant being the Messrs. Drummond, executors of Smithson. Although there was no contest at any point, the suit occupied three years. On May 9th, 1838, the property was adjudged to the United States, and during the next few months disposed of by Mr. Rush for about £105,000. The money was deposited in the Treasury in the following autumn.

The problem now presented to Congress was to organize the Institution described by Smithson. The writer must confess that he does not share the views of those who maintain that the intent of Smithson was too clear and definite to be mistaken, and that the difficulty which our legislators found in deciding upon a plan shows their lack of intellectual appreciation. It is very much easier to see the right solution of a problem after it is obtained than before. It ought to be a subject of gratitude rather than of criticism that it took the country eight years to reach a

Digitized by Google

conclusion. The plan at length adopted was better than any of those previously proposed, and the form into which the Institution grew was still in advance of the plan which at length passed Congress.

Whatever view we may take of this point, the diversity of projects considered by Congress shows that the meaning of the will was not made clear to our legislators. First of all there was a body of strict constructionists who maintained that our Government had no power to accept a bequest of the kind, and that the money should be returned to the English Court of Chancery. One Fleischmann, an employé of the Patent Office, petitioned for the establishment of an agricultural school, and his memorial seems to have received much attention. Another memorialist prayed for the establishment of an institution for prosecuting physical experiments, and a third that the fund might be applied to the instruction of females. A vigorous effort was made by the Columbian College to obtain assistance from the fund. Mr. John Quincy Adams desired to appropriate a considerable amount to the establishment of a great astronomical observatory. Mr. F. A. Hassler, Superintendent of the Coast Survey, desired the establishment of an astronomical school before the erection of Mr. Adams's observatory. A strong move was made by Mr. Poinsett to place the whole fund at the disposal of the National Institute for the Promotion of Literature and Science. Mr. James P. Espy, the meteorologist, proposed that a portion of the fund should be devoted to meteorological observations all over the Union. Mr. Franklin Knight wished the whole fund applied to the establishment of a farm school.

After a seven years' discussion of these and other projects and combinations, the act under which the Institution was at last organized became a law in August, 1846. It provided that the business of the Institution should be conducted by a Board of Regents, who should choose a suitable person as Secretary of the Institution. It also provided for the erection of a suitable building of plain and durable materials and structure, without unnecessary ornament, for the reception of objects of natural history, a chemical laboratory, a library and gallery of art, and the necessary lecture-rooms. The Secretary had charge of the building and property of the Institution, and was also to discharge the duties of librarian and keeper of the museum, and,

Digitized by Google

with the consent of the Board of Regents, to employ the necessary assistants. All the officers were removable by the Board of Regents whenever in their judgment the interests of the Institution required them to be changed.

The Board of Regents created by the act immediately commenced active operations. In December, 1846, a committee of the Board, consisting of Mr. Robert Dale Owen, Mr. Henry N. Hilliard, Professor A. D. Bache, Mr. Rufus Choate, and Mr. Pennybacker, made a report on the plan of organization. Among the recommendations of this report the qualifications desired in the Secretary are of interest to us. It was pointed out as an almost necessary condition that the Secretary should become the chief executive officer of the Institution. After some general remarks respecting the qualifications of Secretary the report proceeds:

"Your committee think it would be an advantage if a competent Secretary could be found, combining also the qualifications of a professor of the highest standing in some branch of science. If to these be added efficiency as an executive officer and a knowledge of the world, we may hope to see filling this distinguished post a man who, when brought into communication with distinguished men and societies in this and other countries, shall be capable, as representative of the Smithsonian Institution, to reflect honor on the office, not requiring to borrow distinction from it.

"Your committee will not withhold their opinion that upon the choice of this single officer, more probably than on any other act of the Board, will depend the future good name and success and usefulness of the Smithsonian Institution."

Previous to the election of Secretary the following resolution, from the same committee, was adopted by the Board:

"*Resolved*, That it is essential, for the advancement of the proper interests of the trust, that the Secretary of the Smithsonian Institution be a man possessing weight of character, and a high grade of talent; and that it is further desirable that he possess eminent scientific and general acquirements; that he be a man capable of advancing science and promoting letters by original research and effort, well qualified to act as a respected channel of communication between the Institution and scientific and literary individuals and societies in this and foreign countries; and, in a word, a man worthy to represent before the world

Digitized by Google

of science and of letters the Institu tion over which this Board presides."

Although couched in general terms it may be supposed that these expressions had direct reference to the subject of our notice, and were meant to justify the Board in selecting a scientific investigator of so much eminence to take charge of the establishment. Professor Henry was elected on December 3, 1846, and signified his acceptance a few days later. It was a frequent remark of his in after years that he had never sought a position, and had never accepted one without fear and trembling. Of the few positions he ever accepted we might well suppose that this was the one on which he entered with most hesitation. His position at Princeton was in every respect most agreeable. His enthusiasm as a teacher could not fail to bring around him an appreciative body of pupils. He was not moved by any merely worldly ambition to seek a larger and more prominent field of activity, and was held in the highest esteem by the authorities of the college. He thus enjoyed what is almost the happiest lot of man, that of living in a community suited to his tastes and pursuits, and of being held in consideration by all with whom he came into contact. He was now to take a position around which had raged for eight years a conflict of opinion which might at any time break out anew. That all parties could be satisfied was out of the question, and his aversion to engaging in anything which would lead to controversy was so great that he would hardly have accepted had it not been for the urgent solicitation of Professor Bache. The latter pointed out to him that the proper administration of Smithson's munificent bequest was at stake, and that he, Henry, was the only man available to whom all parties could turn with the assurance that the Institution would be carried through its difficulties. This was an appeal which he could not withstand; he therefore determined at least to make the attempt, and entered upon his duties with the assurance from the college authorities that, should he fail, his position at Princeton would always be open to him, and his friends ever ready to welcome him back.

After two or three years the divergent views respecting the proper direction to be given to the activities of the Smithsonian Institution gradually began to aggregate themselves into two groups and thus to assume a partisan aspect. Many of the pro-

Digitized by Google

jects which, during the eight years of discussion, had found supporters, were entirely given up, such, for instance, as the agricultural college, a great observatory, the instruction of women, and the establishment of a school of science. But the act of Congress provided, as already stated, for a library, a museum, a gallery of art, and courses of lectures. Henry, while yielding to the necessity imposed upon the Institution of complying with the law directing the establishment of these accessories, was in the main opposed on principle to their permanent support by the Institution. The position he took was that as Smithson was a scientific investigator, the terms of his endowment should be construed in accordance with the interpretation which he himself would have put upon his words. The increase of knowledge would mean the discovery of new truths of any sort, especially the truths of nature. The only way in which an extended diffusion of increased knowledge among men at large could be effected was by publication.

The departments of exploration, research, and publication were therefore those to which Henry was most inclined to devote the energies of the Institution. While he made no factious opposition to the collection of a library, he did not consider it as increasing knowledge or contributing to that wide diffusion of it which Smithson provided for. True, it might indirectly contribute to such diffusion by giving authors the means of preparing books; but this assistance was of too local and indirect a character to justify the appropriation of a large proportion of the Smithson funds to it. Nearly the same objections applied to the museum. The objects therein preserved were the property of the Government, and the contributions to its increase would naturally come, for the most part, from Government explorations. The explorations undertaken on behalf of the Institution would naturally be only such as, from their nature, would not be undertaken by the Government, or such as were necessary to supplement the governmental collections.

That a gallery of art would neither increase nor diffuse knowledge on the plan required by Smithson hardly needed argument. It does not seem that any serious attempt was ever made to carry out this part of the project on any considerable scale. The Indian portraits which constituted the principal part of the collec-

Digitized by Google

tion of paintings were, the writer believes, the private property of Mr. Stanley, the artist.

Perhaps the project on which the Secretary looked with most disfavor was the building. The system of operations which he would have preferred required little more than a modest suite of office-rooms. The expenditure of several hundred thousand dollars on an architectural structure seemed to him an appropriation of the funds to which he could give no active encouragement. In later years one of the warnings he often gave to incipient institutions of learning was not to spend more money in bricks and mortar than was absolutely necessary for the commencement of operations, and it can hardly be doubted that his sentiments in this direction had their origin in his dissatisfaction with the large expenditure upon the Smithsonian building.

We must not be understood as saying that Henry antagonized all these objects, considered them unworthy of any support from the Smithsonian fund, or had any lack of appreciation of their intellectual value. His own culture and mental activities had been of too varied a character to admit of his forming any narrow view of the proper administration of the establishment. The general tenor of his views may be summed up in two practical propositions:

(1.) The Institution should undertake nothing which could be done by other agencies. A paper or report which would naturally find its outlet in some other channel was never to be published by the Institution. A research made for a commercial object would find plenty to engage in it without his encouragement. It was the duty of the Government to provide room for its own collections and to make them accessible to investigators, rather than to draw upon the Smithson fund for this purpose. As a natural corollary of these views the Institution should not engage in competition with other organizations in any enterprise whatever.

(2.) Objects of merely local benefit, which no one could avail himself of except by a visit to Washington, were to be regarded as of subsidiary importance, as not well fitted to carry out the views of Smithson to the wide extent he would have desired, and as properly belonging to the local authorities.

Putting both these principles together, the library, the museum, the art gallery, the courses of lectures, and the Smithsonian build-

Digitized by Google

ing were looked upon as things only temporarily undertaken by the Institution, to be turned over to other agencies whenever such could be found ready to assume the responsibility of the operations connected with them.

The affairs of the Institution went on for several years without any interruption. The general policy of the Secretary was to keep the expenditure upon those objects which he considered least germane down to the lowest limit consistent with the law and with the resolutions of the Board of Regents, hoping gradually to win the Board over to his views. Among the accessories on which he wished to retrench, the library was the only one which gave serious trouble. In the act organizing the establishment, the Regents were authorized to make an annual expenditure, not exceeding an average of $25,000, "for the gradual formation of a library composed of valuable works pertaining to all departments of human knowledge." This sum was two-thirds of the whole annual income, and had the provision been mandatory would have left little means for active operations. At a meeting of the Board the day after the election of Professor Henry the sum of $20,000 had been appropriated for the purchase of books and the fitting up of the library. Amendments reducing the sum to $12,000 and $15,000 were successively voted down. At another meeting a more definite plan of operations was agreed upon, to take effect after the completion of the building. This was a compromise, under which one-half of the annual income should be devoted to the library, the museum and the gallery of art, and one-half to the transactions, reports, publications, lectures, and original researches. The library project thus commenced as the leading feature of the Institution. It was greatly strengthened by the character of the assistant whom Professor Henry called to its charge, Mr. C. C. Jewett, formerly librarian of Brown University, a gentleman whose high character and professional ability marked him as well fitted to undertake the work of collecting and arranging a great library. Mr. Jewett very naturally desired to expend the full admissible amount upon his department, and thus a difference gradually arose between him and his chief, which widened as the building approached completion. He began to assert his claims to an extent which met the strong disapproval of the Secretary, and in 1854 the difference culminated in an appeal to the Board of Regents.

Digitized by Google

The question was first brought before the Board in the form of a resolution respecting the proper division of the fund. In April, 1854, the executive committee recommended an appropriation in which only $6,000 was devoted to the library, more than half of which was for the salary of librarian and assistants. The appropriation for the purchase of books was only $1,800. In presenting this recommendation the committee say that they have not recommended an equal distribution between the active operations, on the one hand, and the library, museum, &c., on the other, because the compromise resolutions which required such equality of distribution do not go into effect until after the completion of the building.

This reduction was opposed by the other party on both legal and political grounds. Two members of the Board presented resolutions relative to the distribution of the income, which were referred to a subcommittee. This committee, through Hon. J. A. Pearce, its chairman, made a very elaborate report on May 25th following, reviewing the whole subject at great length, reciting what the Institution had done, and justifying the small appropriation for the library. The report closed with resolutions repealing the compromise arrangement, and leaving the apportionment among the different objects to the judgment of the Regents.

In the meantime the difference between the Secretary and the librarian reached a stage at which the further coöperation of both in the affairs of the Institution was no longer practicable. The Secretary made known his intention of removing the librarian, taking the ground that while the Board of Regents had power to remove either the Secretary or his assistants, the Secretary himself could remove the latter without reference to the Board. A resolution to this effect was introduced by Mr. James M. Mason, of Virginia. The question was, in principle, the same which has been raised from time to time since the foundation of our Government relative to the general power of superior officers over their subordinates in cases where the law makes no express provision. Under the terms of the organic act the Secretary and the Board of Regents, so far as the assistants were concerned, stood in nearly the same relation to each other that the President and Senate stand under the National Constitution. The Secretary, as executive, had the power of appointment with the consent of the Board of Regents, but the law was silent on the

Digitized by Google

subject of removal. Mr. Mason's resolution, after several amendments had been voted down, was adopted by a vote of 6 to 4, and the position of the Secretary as the responsible head of the Institution was thus fully defined.

It would, however, appear that Mr. Jewett continued his efforts to secure a larger appropriation for the library than the Secretary or the executive committee considered desirable, and carried his opposition to such a point that the Secretary removed him from office on the 12th of January following.

The resolution of the executive committee repealing the compromise and leaving future annual apportionments to the judgment of the Regents was then passed by a vote of 9 to 5. A further resolution to the effect that a compliance in good faith with the letter and spirit of the charter required a large proportion of the income of the Institution to be appropriated for a library was lost.

Mr. Rufus Choate, who had been the most active supporter of Mr. Jewett and the library scheme, now resigned his position as Regent, and accompanied his resignation with a letter addressed to the Senate and House of Representatives, stating his reasons for the course he had taken, and expressing the opinion that the Smithsonian fund was being managed on a system not in accordance with the provisions of the organic act. In the Senate the subject was referred to the Committee on the Judiciary, which made a unanimous report in favor of the majority of the Board of Regents. In the House there was a more serious contest. Mr. Choate's letter was referred to a select committee of five, appointed to inquire and report to the House whether the Smithsonian Institution had been managed and its funds expended in accordance with law, and whether any additional legislation was necessary. After a careful examination, extending through a period of six weeks, the committee seems to have been unable to agree upon a report. Two reports were, in fact, made. One, signed only by Mr. Upham, the chairman, took ground against the power of removal by the Secretary of the Institution, and against the restriction of the increase of the library as contemplated. Another very elaborate report, signed by two members, sustained the Secretary and the majority of the Board. The remaining two members of the committee signed neither report;

Digitized by Google

nor did either report propose any action on the part of Congress except the payment of the clerk of the committee.

The contest which had been going on for a period of seventeen years thus ended in a complete vindication of Professor Henry and the position he had assumed. During the remainder of his life he had the great satisfaction of feeling that he was held in constantly increasing esteem both by the Regents and the public.*

In January, 1865, an event occurred which, though an almost irreparable calamity, tended materially toward the appropriation of the Smithsonian income toward those objects which the Secretary thought most proper. A considerable portion of the upper story of the main building and a part of the lower story were burned. The incipient art gallery, the chemical laboratory, and the lecture-room were all involved in the destruction. Happily the library and the museum remained nearly intact. An opportunity thus offered itself to have some of the trusts imposed upon the fund undertaken by other agencies. The Library of Congress was rapidly growing into a great national institution, so that there was no longer any sound reason for collecting a separate Smithsonian library. An act was therefore passed by Congress providing for the deposit of the Smithsonian books in the Library of Congress, so that all could be consolidated together and the Institution at the same time be relieved from their care. The necessity for reconstructing the art gallery was obviated by the prospective establishment of the Corcoran Art Gallery in a neighboring part of the city. The erection of Lincoln Hall and the establishment of courses of lectures, sometimes of a high intellectual character, by the Young Men's Christian Association, did away with the necessity of reconstructing the lecture-room. The principal immediate drawback was that the building had to be reconstructed at the expense of the Smithsonian fund, although Professor Henry was not entirely satisfied that so large a building was necessary for the Institution.

The only serious burden which remained upon the Institution was the National Museum; but the expense of its support was now undertaken by the Government, and it therefore ceased to

* As an expression of Professor Henry's views in his own language we append to this address an extract from his examination before the English Government Scientific Commission.

Digitized by Google

be a charge upon the Smithsonian fund except in this indirect way that the building which housed it had been paid for out of that fund. No advantage would therefore have been gained by removing the museum unless the building was purchased by the Government. The Secretary was therefore desirous of effecting such a sale, but his views do not appear to have met with the entire concurrence of the Board of Regents. The latter were not unnaturally averse to seeing the Institution surrender its imposing habitation and the associations which clustered around it. A very natural compromise would have been for the Government to pay the Institution a suitable moderate rent for those portions of the building devoted to the care of Government property, but it does not appear that this measure was ever proposed.

The position of the Smithsonian building in the public grounds led Professor Henry to take an active interest in measures for the improvement of the city. Among his latest efforts in this direction were those made with the object of having the old canal which bounded the Mall filled up. Some of us may remember a witty argument with which he urged this measure upon the Board of Public Works. "The great inefficiency of the Smithsonian had been said by its opponents to be illustrated by the fact that, although formed to diffuse knowledge over the whole world, it had not diffused knowledge enough among the local authorities where it was situated to make them see the necessity of abating the pestilential nuisance of this obsolete canal." The work of filling up was immediately commenced by the board to which the argument was addressed.

The following extract from one of Professor Henry's early journals will be of interest as showing the character of his early efforts for the improvement of the Smithsonian grounds:

"NOVEMBER 25, 1850.

"Occupied this morning examining the public grounds between the Capitol and the Monument. I have been impressed since my connection with the Smithsonian Institution with the importance of improving the public grounds on which the Smithsonian is placed in accordance with a general plan, and I have taken every opportunity of expatiating on the capacity of the Mall to be made one of the most beautiful drives in the world. My enthusiasm on this point was much dampened a

Digitized by Google

few months ago, when it was proposed to place the Botanic Garden on the Mall near the Smithsonian. The site was chosen and, as I supposed, all things settled, when to my surpise some influence at once changed the location.

"My interest in the project was again awakened by a movement on the part of Mr. Corcoran. An appropriation was made to improve the grounds around the President's House. Mr. Corcoran was interested in the square opposite his residence. He requested me to go with him to the President to ask him to interfere. We called on the President, who manifested an interest in the subject but said he had no power to act, but if we would show him the authority he would do what he could to forward the object. On this assurance Mr. Corcoran and myself left the President, and I was requested to search for the law authorizing the action of the President. For this purpose I called upon Peter Force, who, after a search of some time, found the law, gave me a copy, which I afterwards presented to the President. The same evening I called a meeting at the office of the mayor, of Mr. Mudd, the commissioner of public buildings, and the mayor. After some conversation it was at length concluded to send for some competent landscape gardener to give a general plan of the improvements, and, on the suggestion of the mayor, it was resolved to request the President to direct that Mr. Downing, from Newburgh, be requested to examine the grounds and report a plan of improvement. We (the mayor, Mr. Mudd, and myself) called next day on the President, presented the matter, and received from him the sanction for writing to Mr. Downing. A few days after this I started for New Jersey and was absent several days, and when I returned I found that nothing had been done,—Mr. Downing had not been written to. I therefore drew up a form of a letter of invitation in accordance with my views of the manner in which the invitation should be worded, and sent this to the commissioner. This letter was sent, and in conformity with this invitation, Mr. Downing has come on. I called with Mr. Downing on the President, who gave us a very pleasant reception and entered with much interest into the plans of Mr. Downing. This morning Mr. Mudd, Mr. Downing, and myself have examined all the ground between the Capitol and the river, and found it admirably adapted to the formation of a landscape garden and a drive."

Digitized by Google

The administration of the Smithsonian Institution does not appear to have been compatible with the continuance of the experimental researches in which our colleague was so eminently successful during the earlier years of his life. The fact is that the general science of electricity was passing almost beyond the experimental and into the mathematical stage, so that little of real value could be effected by mere experimentation without reference to purely mathematical theories. But it would be altogether a mistake to suppose that his scientific activity was diminished or that his contributions to knowledge were confined to his earlier days. The talent which had before been directed to investigations of a purely scientific character (understanding by this term such as were designed only to improve the theories of natural phenomena) was now turned to practical application of scientific principles. Whether such applications are less worthy of the investigator than the advancement of purely theoretical notions, we shall not attempt to discuss, but shall only remark that our colleague brought into his new field that same unselfish devotion to the intellectual interests of mankind which marks the purely scientific investigator. Whatever utilitarian objects he may have aimed at, they had no personal reference to himself. He never engaged in an investigation or an enterprise which was to put a dollar into his own pocket, but aimed only at the general good of the world.

One of the earliest of his new enterprises was that of receiving notices of the weather by telegraph and exhibiting them upon a map, thus laying the foundation of our present meteorological system. In 1847 he called the attention of the Board of Regents to the facilities which lines of telegraph would afford for warning observers to be on the watch for the approach of a storm. As a part of the system of meteorology, the telegraph was to be employed in the investigation of atmospheric phenomena. The advantage to agriculture and commerce to be derived from a knowledge of the approach of a storm was recommended as a subject deserving the attention of Government. About 1850 the plan of mapping the weather was instituted. Many of us remember the large maps of the country suspended in the entrance to the Institution, on which the state of the weather in different regions was indicated by movable signs. This system continued

Digitized by Google

until 1861, when the breaking out of the civil war prevented its further continuance.*

After the close of the war a renewal of the system was proposed and some efforts made for the attainment of this object. But with this, as with every other enterprise, Professor Henry would never go on with it after any one else was found ready to take it up. In 1869 our colleague, Professor Abbe, commenced the issue of regular weather bulletins from the Cincinnati Observatory, showing the state of the weather at a number of telegraphic stations, followed by a brief forecast of the weather which would probably be experienced at Cincinnati during the next twenty-four hours. About the same time provision was made by Congress for the national system now so thoroughly organized by the Chief Signal Officer of the Army. This system received the cordial support of Professor Henry, who gave every facility at the disposal of the Institution to General Myer for the completion of the organization, and, indeed, turned over the whole practical part of the subject to him.

Among the services of Professor Henry outside of the field of pure science and of the administration of the Smithsonian Institution the first place is due to those rendered in connection with the Light-House Board. This Board was organized by act of Congress in 1852 to discharge all administrative duties relating to the light-house establishment on the American coasts. The duties assigned to Professor Henry in this connection included experiments of all kinds pertaining to lights and signals. The illuminating power of various oils was made the subject of exact photometric experiments, and large sums were thus saved to the Government by the adoption of those illuminators which gave most light in proportion to cost. The necessity of fog signals led to what are, for our present purpose, the most important researches in this connection, namely, his investigations into the phenomena of sound. Acoustics had always been one of his favorite subjects. As early as 1856 he published a carefully prepared paper on the acoustics of public buildings, and he frequently criticised the inattention of architects to this subject. His regular investigations of sound in connection with the Light-

*See Historical Notes on the System of Weather Telegraphy, by Cleveland Abbe. *American Journal of Science and Arts*, volume ii, 1871, page 81.

Digitized by Google

House Board were commenced in 1865. It had long been known that the audibility of sounds at considerable distances, and especially at sea, varies in a manner which has seemed quite unaccountable. There were numerous instances of a sound not becoming audible until the hearer was immediately in its neighborhood, and others of its being audible at extraordinary distances. Very often a sound was audible at a great distance and was lost as the hearer approached its source. The frequency of fogs on our eastern coasts and the important part played by sound signals in warning vessels of danger rendered it necessary to investigate the whole theory of the subject.

One of the first conclusions reached related to the influence of reflectors and of intervening obstacles. That a sound in the focus of a parabolic reflector is thrown forward and intensified in the manner of light has long been a well-known fact. The logical consequence of this is that the sound is cut off behind such a reflector, so that at short distances it is many times louder in front of the reflector than behind it. In the case of light, which moves in right lines, it is well known that such an increased volume of light thrown in one direction will go on indefinitely. But in the case of sound the law was found to be altogether different—the farther the observer went away from the source, the less the influence of the reflector, and at the distance of two or three miles the latter was without effect,—the sound being about equally audible in whatever direction the reflector might be turned. Another important discovery, made the following year, was that when a sound was moving against the wind it might be heard at an elevation when it was inaudible near the surface of the water.

These observations were continued from time to time during the summer season until 1877. They resulted in collecting an immense mass of facts, including many curious abnormal phenomena, descriptions of which are found in the annual reports of the Light-House Board. Our president was extremely cautious in formulating theories of the subject, and had no ambition of associating his name with a generalization which future researches might disprove. The result of his observations however was to show that there were none of these curious phenomena which might not be accounted for by a species of refraction arising from varying atmospheric currents. The possible effects of

Digitized by Google

this cause had been pointed out by Professor Stokes, of England, in 1857, and the views of the latter seem to have been adopted by Henry. One of the generalizations is very clearly explained on this theory: A current of air is more rapid at a short height above the water than at its immediate surface. If a sound-wave is moving with such a current its upper part will be carried forward more rapidly than its lower part; its front will thus be presented downward and it will tend to strike the water. If moving in an opposite direction against the wind, the greater velocity of the latter above the water will cause the upper part of the sound-wave to be retarded. The wave will thus be thrown upward, and the course of the sound will be a curved line convex to the water. Thus an observer at the surface may be in a region of comparative silence, when by ascending a few yards he will reach the region of sound vibration. A corresponding effect would be produced by a difference in the motions of two contiguous bodies of air, whether the line of change was vertical or horizontal. As we know very well that the motion of the air is by no means uniform, and that eddies, gusts, and whiffs prevail nearly everywhere, it is to be expected that sound will not always move uniformly in a direct line, but will be turned from its direct course by the sort of refraction that we have described. It is however impossible to prove by observation that this is the only cause of the abnormal phenomena referred to, because the exact velocity of local currents within a space over which the sound extends cannot be a subject of observation. Professor Henry was however disposed to claim that, having a sufficiently general known cause to account for the phenomena, it was not philosophical to assume other causes in the absence of decisive proof.

It was at the light-house station in the month of December, 1877, that Professor Henry noticed the first symptom of the disorder which terminated his life a few months later. After passing a restless and uncomfortable night, he arose in the morning, finding his hand partially paralyzed. A neighboring physician, being sent for, made a prognosis of a very serious character. A more detailed subsequent examination by two members of our Academy led to the conclusion that he was affected with an incipient nephritis. Although no prospect of recovery could be held out, it was hoped that the progress of the disease would be

Digitized by Google

so slow that, with his healthy constitution, he might still endure for a considerable period. This hope however rapidly faded. During the winter the disease assumed so decided a form as to show that his active work was done and that we could have him with us but a few months longer. But beyond a cessation of his active administrative duties there was no change in his daily life. He received his friends, discussed scientific matters, and took the most active interest in the affairs of the world so long as his strength held out. It was a source of great consolation to his family and friends that his intellect was not clouded nor his nervous system shattered by the disease. One of the impressive recollections of the writer's life is that of an interview with him the day before his death, when he was sustained only by the most powerful restoratives. He was at first in a state of slumber, but, on opening his eyes, among the first questions he asked was whether the transit of Mercury had been successfully observed and the appropriation for observing the coming total eclipse secured. He was then gradually sinking, and died at noon on May 13, 1878.

A mere sketch, like the foregoing, of the lines of activity followed out by our late President, gives no adequate idea either of his mental force or of his public services. The contributions to science of an American of the last few generations afford an entirely insufficient standard of judgment, though it is a standard which writers are prone to adopt as if it were the only one. We are apt to forget that science is a plant of cultivation which rarely or never flourishes in a state of isolation, and reaches full fruition only when it can absorb into its own growth the fertile ideas of many associated minds. Leaving out a few powerful intellects who started our modern system of investigating nature, a high development of the scientific spirit has been attained only by a communion of ideas through the medium of academies, institutions, and journals. We may pronounce it an entire illusion to suppose that a professor in one of our ordinary American colleges, without personal contact with men engaged in similar pursuits, and without access to the publications in which foreign investigators publish their researches, can permanently take a leading position in any branch of investigation. If it shall appear that Henry's contributions to electricity were less numerous and brilliant than those of Faraday, let us consider not sim-

Digitized by Google

ply the immensely wider field of Henry's intellectual and public activity, but the different situations of the two men. The one occupied the focus of the intellectual metropolis of the world, commanding at pleasure every sort of apparatus which money could purchase or art produce, and was surrounded by an admiring crowd of the *élite* of society, eagerly hearing of his every discovery and listening attentively to all his utterances. The other was, during his early prime, an overworked instructor, almost out of the reach of the great treasures of foreign scientific literature, and with none of the advantages enjoyed by his great competitor.

Another circumstance not to be lost sight of is that Henry, in obedience to one of the great principles of his life, voluntarily relinquished to others each field of investigation at the very time when he had it so far cultivated that it might yield him fame and profit. It is an unfortunate fact that the world, in awarding its laurels, is prone to overlook the sometimes long list of those whose labors have rendered a result possible, and to remember only the one who gave the finishing stroke, or applied previously known principles to some useful result. There are few investigators to whom the criterion in question would do less justice than to the subject of our notice. In his unselfish devotion to knowledge he sowed that others might reap on the broad humanitarian ground that a valuable harvest would be sure to find a reaper while the seed might wait in vain for a sower. Had this been done solely in his individual character we should have looked upon his course with admiration; but in bringing the principle into the administration of the Smithsonian Institution he avoided a danger and rendered a benefit for which we cannot be too grateful. To this principle is due the fact that the Institution never appeared as a competitor, seeking an advantage for itself, but always as the active coöperator in every enterprise tending to carry out the object prescribed by its founder.

Notwithstanding a uniform adherence to this course through his whole life, it would be difficult to find a physicist of our time whose researches cover more ground than his do. Any adequate analysis of his published papers and notices would transcend the limits of the present memoir. Besides his electrical researches, they include meteorology in almost all its phases,

Digitized by Google

the physical geography of his native State, terrestrial magnetism, capillarity, molecular physics, observations of meteors, phosphorescence, solar physics, protection from lightning, observations of the aurora, the radiation of heat, the strength of building materials, experiments on an alleged spontaneous separation of alcohol and water, aeronautics, the ventilation of buildings, the phenomena of sound, and various other subjects hardly admitting of classification.

Notwithstanding his literary productiveness, he rarely if ever wrote a paper to yield him the honorarium of a magazine contributor. Nor did he ever seek a source of income beyond the modest salary paid him for administering the Smithsonian Institution. This sufficed, not only to satisfy the wants of a simple mode of life, but, with the aid of the accommodations allowed him in the building, to dispense a hospitality to a wide circle of friends and admirers as pleasant to the recipients as if it had won the title of princely. Although not drawing a salary from the Government, and entitled therefore to compensation for any services rendered, his numerous public services were entirely gratuitous. It must however be said to the credit of our Government that after his death Congress voted his family a small compensation for his twenty-five years of administrative service in the offices of member and president of the Light-House Board.

One of his interesting traits of character, and one which powerfully tended to make the Smithsonian Institution popular and useful, was a certain intellectual philanthropy which showed itself in ceaseless efforts to make others enjoy the same wide views of nature which he himself did. He was accessible to a fault, and ever ready to persuade any honest propounder of a new theory that he was wrong. The only subject on which the writer ever had to express to him strong dissent from his views was that of the practicability of convincing "universe-makers" of their errors. They always answered with opposing arguments, generally in a tone of arrogance or querulousness which deterred even the modest Henry from replying further; but in spite of oft-repeated failure he still considered it a duty to do what he could toward imbuing the next one of the class who addressed him with correct notions of scientific theories.

It is hardly necessary to say that in Professor Henry's mental composition were included a breadth of intellect, clearness of

Digitized by Google

philosophic insight, and strength of judgment, without which he could never have carried out the difficult task which his official position imposed upon him. His mental fiber was well seen in the stand which he took against the delusions of spiritualism. On no subject was he more decided than on that of the impossibility and absurdity of the pseudo-miracles of the mediums, who seemed to him to claim no less a power than that of overruling the laws of nature. An intellectual person yielding credence to their pretensions seemed to him to be in great danger of insanity. An old and respected friend, who had held a prominent position in the Government service, in speaking to him on the subject, once described how he had actually seen a spiritual medium rise in the air and waft himself out of the window. "Judge," answered the Professor, "you never saw that, and, if you think you did, you are in a dangerous mental condition. If you do not give this delusion up you will be in the insane asylum before you know it. As a loving friend I beseech you to take warning of what I say, and to reflect that what you think you saw is a mental delusion which requires the most careful treatment."

He used frequently to relate a curious circumstance as an illustration of the character of this "spiritual" legerdemain. A noted spiritualist had visited Washington during Mr. Lincoln's administration, and held several seances with the President himself. The latter was extremely desirous that Professor Henry should see the medium, and give his opinion as to how he performed his wonderful feats. Although Henry generally avoided all contact with such men, he consented to receive him at the Smithsonian Institution. Among the acts proposed was that of making sounds in various quarters of the room. This was something which the keen senses and ready experimental faculty of the Professor were well qualified to investigate. He turned his head in various positions while the sounds were being emitted. He then turned toward the man with the utmost firmness and said, "I do not know how you make the sounds, but this I perceive very clearly: they do not come from the room but from your person." It was in vain that the operator protested that they did not, and that he had no knowledge how they were produced. The keen ear of his examiner could not be deceived.

Some time afterward the Professor was traveling in the east,

Digitized by Google

and took a seat in a railway car beside a young man who, finding who his companion was, entered into conversation with him, and informed him that he was a maker of telegraph instruments. His advances were received in so friendly a manner that he went further yet, and confided to him that his ingenuity had been called into requisition by spiritual mediums, to whom he furnished the apparatus necessary for the manifestations. Henry asked him by what mediums he had been thus engaged, and was interested to find that among them was the very man he had met at the Smithsonian. The sounds which the medium had emitted were then described to the young man, who in reply stated that the apparatus had been constructed by himself, and explained its structure and working. It was fastened around the muscular part of the upper arm, and so devised that the sounds would be produced by a simple action of the muscle, unaccompanied by any motion of the joints of the arm, and therefore entirely invisible to a bystander.

A trait of Professor Henry's character which contributed powerfully to his success and usefulness was the many-sidedness of both his intellect and his taste. The great development of the imaginative and æsthetic faculties which led to the precocious dramatic activity of his boyhood made itself felt throughout his life. Although he did not seek to beautify his public addresses or communications with ornaments drawn from foreign sources, he was always ready with an apt quotation to clothe a sentiment. Apart from all intellectual and scientific claims, American science could not have desired a more fitting representative and leader at the National Capital, or found one whose personality afforded so little ground for adverse criticism. His principles kept him outside of all competition, jealousies, and cross-purposes, and his purity of motive gave his recommendations a force, founded on the assurance of their entire disinterestedness, which they otherwise could not have commanded. If he had eccentricities or prejudices they were those of the philosopher. The mental qualities so well fitted to secure the affection as well as the respect of all with whom he became intimately acquainted were supplemented by a healthy constitution, an attractive person, and a commanding, yet modest, presence, finely calculated to win confidence.

In conclusion, we believe that we but feebly express the senti-

Digitized by Google

ment of every member of the Academy in saying that our late President will be entitled to the gratitude of posterity as the leader of that intellectual band of the last generation, to whom is due the great advance in the national appreciation of scientific research which we have witnessed during the last thirty years, and that the society of which he would not be an ornament is still beyond our intellectual vision.

Supplemental Note.

The following statement by Professor Henry was made at the request of the English Government Scientific Commission, June 28, 1870, during his visit to London. To the request that he would give the Commission a general idea of the character of the Smithsonian Institution, Professor Henry replied:

"There was at first a great diversity of opinion as to the manner in which the income should be applied to realize the design of the testator, as expressed in the brief but comprehensive terms of the bequest. The distinction at that time between an Institution for the advancement of knowledge by the discovery of new truths, and one for the teaching of the knowledge already in existence, was not so generally recognized as it is at present, and Congress, after several years of delay, placed the expenditures of the income under the care of a Board of Regents, and directed that they should make provision, by the erection of a building and otherwise, for the formation of a library, a museum, and a gallery. It also gave fifty acres of unimproved ground, surrounding the site for the building, with indications that it should be planted with trees. Afterward, however, though not without much opposition, it was concluded by the directors that those objects, although very important in themselves, were too local in their influence to come up to the liberal spirit of the bequest, which was intended not merely to benefit the citizens of Washington, nor even exclusively those of the United States, but mankind in general; and that the efforts of the directors should be to induce Congress to make a separate appropriation, from the public treasury, for the support of the objects just mentioned, and to devote, as far as possible, the income of the Smithsonian fund to the direct increase and diffusion of knowledge, by promoting original researches, and by distributing accounts of the

Digitized by Google

results of these to every part of the civilized world. In this the directors have been in a great measure successful, though time and much persevering labor have been required to produce a change in the policy originally contemplated. A large portion of the income of the funds has been expended on the building. A library, principally consisting of nearly a full series of the proceedings and transactions of the existing learned societies of the world, has been accumulated, the expense of the care of which has absorbed another portion of the income; a museum has been collected, consisting principally of specimens to illustrate the natural history and ethnology of America, and also a collection of engravings and plaster casts to meet the original requirements of Congress as to a gallery of art; but experience has abundantly proved that any one of the specified objects, if properly sustained, would soon absorb all the income of the bequest, and vindicated the policy of transferring the support of them to other funds. In accordance with this, Congress was first induced to take charge of the grounds and take the steps necessary for their improvement. It next took charge of the books which had been collected and incorporated them with the national library, giving the Institution and its collaborators the free use of the books of both collections. By this transfer the Institution is saved, in the expense of binding, cataloguing, and attendance, nearly $10,000 annually, while it has the same use of its books as before the arrangement was made. Again, the Agricultural Department has taken charge of the plants of the Institution, and the osteological specimens have been transferred to the Army Medical Museum. Furthermore, a wealthy citizen of Washington has made a large appropriation of money to establish and support a gallery of art, and it is proposed to transfer to this the articles which the Institution has accumulated in the line of art. The object of this policy is to establish at Washington a collection of objects of nature and art, without trenching on the Smithsonian fund, which shall be worthy the capital of the nation. As a step toward this desirable end, Congress, at its present session, has appropriated $10,000 towards the support of the museum, under the care of the Institution, and also $10,000 for the commencement of the fitting up of the upper story of the Smithson building for the better display of

Digitized by Google

the collections. The $10,000 for the care of the museum will, for the present, be an annual appropriation."

Q. "What does the building itself represent?" A. "Externally a Norman castle, and it has cost a very large sum. Unfortunately, architecture is frequently in antagonism with science, and, too often, when an architect gets his hand into the purse of an establishment everything else must stand aside. Much trouble has resulted from this building; it has been a source of constant anxiety and expense,—the cost having greatly exceeded the original estimate."

Q. "What was the original object of the building?" A. "It was intended to accommodate a library, a museum, and a gallery of art, but, inasmuch as the Institution has turned over the library and the gallery of art to other establishments, the building will now be devoted entirely to the museum. The upper part of it was burnt, and it remains unfinished; and if Congress would accept the building as a gift, allowing one of the wings for the use of the Institution, and devoting the main portion to the museum, it would be a gain to the Institution."

LIST OF THE SCIENTIFIC PAPERS OF JOSEPH HENRY.*

1825. On the Production of Cold by the Rarefaction of Air, accompanied with Experiments. (Presented March 2.) Abstract, *Trans. Albany Institute*, vol. i, part ii, p. 36.

1827. On some Modifications of the Electro-magnetic Apparatus. (Read Oct. 10.) *Trans. Albany Inst.*, vol. i, pp. 22-24.

1829. Topographical Sketch of the State of New York; designed chiefly to show the General Elevations and Depressions of its Surface. (Read Oct. 28.) *Trans. Albany Inst.*, vol. i, pp. 87-112.

1829. First Abstract of Meteorological Records of the State of New York for 1828. (In conjunction with Dr. T. Romeyn Beck.) *Annual Report of Regents of University*, to the Legislature of New York.—Albany, 1829.

1829. On the Mean Temperature of Twenty-seven different Places in the State of New York, for 1828. (In conjunction with Dr. T. Romeyn Beck.) Brewster's *Edinburgh Jour. Science*, Oct., 1829, vol. i, n. s., pp. 249-259.

* From the Memorial of Joseph Henry, published by order of Congress, 1880.

Digitized by Google

1830. Second Abstract of Meteorological Records of the State of New York for 1829. (In conjunction with Dr. T. Romeyn Beck.) *Annual Report of Regents of University*, to the Legislature of New York.—Albany, 1830.

1831. On the Application of the Principle of the Galvanic Multiplier to Electro-magnetic Apparatus, and also to the development of great Magnetic power in soft iron, with small Galvanic Elements. Silliman's *American Jour. Science*, Jan., 1831, vol. xix, pp. 400–408. *Jour. of Roy. Institution of Gr. Brit.*, May, 1831, vol. i, pp. 609, 610.

1831. Tabular Statement of the Latitudes, Longitudes, and Elevations of 42 Meteorological Stations in New York. *Annual Report Regents of University*, to Legislature N. Y. 1831.

1831. Third Abstract of Meteorological Records of State of New York for 1830. (In conjunction with Dr. T. Romeyn Beck.) *Annual Report of Regents of University*, to the Legislature of New York.—Albany, 1831.

1831. An Account of a large Electro-magnet, made for the Laboratory of Yale College. (In conjunction with Dr. Ten Eyck.) Silliman's *Am. Jour. Sci.*, April, 1831, vol. xx, pp. 201–203. *Jour. of Roy. Institution of Gr. Brit.*, Aug., 1831, vol. ii, p. 182.

1831. On a Reciprocating Motion Produced by Magnetic Attraction and Repulsion. Silliman's *Am. Jour. Sci.*, July, 1831, vol. xx, pp. 340–343. Sturgeon's *Annals of Electricity*, etc., vol. iii, pp. 430–432.

1832. On a Disturbance of the Earth's Magnetism in connection with the appearance of an Aurora as observed at Albany on the 19th of April, 1831. (Communicated to the Albany Institute, Jan. 26, 1832.) *Report of Regents of University*, to the Legislature of New York.—Albany, 1832. Silliman's *Am. Jour. Sci.*, July, 1832, vol. xxii, pp. 143–155.

1832. Fourth Abstract of Meteorological Records of the State of New York for 1831. (In conjunction with Dr. T. Romeyn Beck.) *Annual Report of Regents of University*, to the Legislature of New York.—Albany, 1831.

1832. On the Production of Currents and Sparks of Electricity from Magnetism. Silliman's *Am. Jour. Sci.*, July, 1832, vol. xxii, pp. 403–408.

1832. On the effect of a long and helical wire in increasing the intensity of a galvanic current from a single element. (Conclusion of preceding paper.) Silliman's *Am. Jour. Sci.*, July, 1832, vol. xxii, p. 408. Becquerel's *Traité expérimental de l'Électricité*, etc., 1837, vol. v, pp. 231, 232.

1833. Fifth Abstract of Meteorological Records of the State of New York for 1832. (In conjunction with Dr. T. Romeyn Beck.) *Annual Report of Regents of University*, to the Legislature of New York.—Albany, 1833.

Digitized by Google

1835. Contributions to Electricity and Magnetism. No. I. Description of a Galvanic Battery for producing Electricity of different intensities. (Read Jan. 14.) *Transactions Am. Philosoph. Society*, vol. v, n. s., pp. 217–222. Sturgeon's *Annals of Electricity*, etc., vol. i, pp. 277–281.

1835. Contributions to Electricity and Magnetism. No. II. On the influence of a spiral conductor in increasing the intensity of electricity from a galvanic arrangement of a single pair, etc. (Read Feb. 6.) *Trans. Amer. Phil. Soc.*, vol. v, n. s., pp. 223–232. Sturgeon's *Annals of Electricity*, etc., vol. i, pp. 282–290. Taylor's *Scientific Memoirs*, vol. i, pp. 540–547.

1835. Facts in reference to the Spark, etc., from a long Conductor uniting the poles of a Galvanic Battery. *Journal of Franklin Institute*, March, 1835, vol. xv, pp. 169, 170. Silliman's *Am. Jour. Sci.*, July, 1835, vol. xxviii, pp. 327–331.

1837. A Notice of Electrical Researches, particularly in regard to the "lateral discharge." (Read before the British Association at Liverpool, Sept., 1837.) *Report Brit. Assoc.*, 1837. Part II, pp. 22–24. Silliman's *Am. Jour. Sci.*, April, 1838, vol. xxxiv, pp. 16–19.

1838. A letter on the production directly from ordinary Electricity of Currents by Induction, analogous to those obtained from Galvanism. (Read to Philosoph. Society, May 4.) *Proceedings Am. Phil. Soc.*, vol. i, p. 14.

1838. Contributions to Electricity and Magnetism. No. III. On Electrodynamic Induction. (Read Nov. 2.) *Trans. Am. Phil. Soc.*, vol. vi, n. s., pp. 303–337. Silliman's *Am. Jour. Sci.*, Jan., 1840, vol. xxxviii, pp. 209–243. Sturgeon's *Annals of Electricity*, etc., vol. iv, pp. 281–310. *L. E. D. Phil. Mag.*, March, 1840, vol. xvi, pp. 200–210; pp. 254–265; pp. 551–562. Becquerel's *Traité expérimental de l'Électricité*, etc., vol. v, pp. 87–107. *Annales de Chimie et de Physique*, Dec., 1841, 3d series, vol. iii, pp. 394–407. Poggendorff's *Annalen der Physik und Chemie*. Supplemental vol. i (Nach Band li), 1842, pp. 282–312.

1839. A novel phenomenon of capillary action, the transmission of mercury through lead. (Read March 15.) *Proceedings Am. Phil. Soc.*, vol. i, pp. 82, 83. Silliman's *Am. Jour. Sci.*, Dec., 1839, vol. xxxviii, pp. 180, 181. *Biblioth. Universelle*, vol. xxix, pp. 175, 176. Liebig's *Annalen der Chemie*, etc., vol. xl, pp. 182, 183.

1839. A Letter on two distinct kinds of dynamic Induction by a Galvanic current. (Read to Phil. Soc. Oct. 18.) *Proceedings Am. Phil. Soc.*, vol. i, pp. 134–136.

1839. Observations of Meteors made Nov. 25, 1835, simultaneously at Princeton and at Philadelphia, for determining their difference of longitude. (In conjunction with Professors A. D. Bache,

Digitized by Google

S. Alexander, and J. P. Espy.) *Proceedings Am. Phil. Soc.*, Dec. 21, vol. i, pp. 162, 163. Silliman's *Am. Jour. Sci.*, Oct., 1840, vol. xxxix, pp. 372, 373.

1840. Contributions to Electricity and Magnetism. No. IV. On Electro-dynamic Induction. (Read June 19.) *Trans. Am. Phil. Soc.*, vol. viii, n. s, pp. 1–18. Silliman's *Am. Jour. Sci.*, April, 1841, vol. xli, pp. 117–152. Sturgeon's *Annals of Electricity*, etc., vol. vii, pp. 21–56. *L. E. D. Phil. Mag.*, June, 1841, vol. xviii, pp. 482–514. *Annales de Chim. et de Phys.*, Dec., 1841, 3d ser., vol. iii, pp. 407–436. Poggendorff's *Annal. der Phys. und Chem.*, 1841, vol. liv, pp. 84–98.

1840. Contributions to Electricity and Magnetism. No. IV,—continued. Theoretical Considerations relating to Electro-dynamic Induction. (Read Nov. 20.) *Trans. Am. Phil. Soc.*, vol. viii, n. s., pp. 18–35.

1840. On the production of a reciprocating motion by the repulsion in the consecutive parts of a conductor through which a galvanic current is passing. (Read Nov. 20.) *Proceedings Am. Phil. Soc.*, vol. i, p. 301.

1840. Electricity from heated Water. (Read Dec. 18.) *Proceedings Am. Phil. Soc.*, vol. i, pp. 322–324.

1841. Report of the Tenth Meeting of the British Association, etc. *Princeton Review*, Jan., 1841, vol. xiii, pp. 132–149.

1841. Description of a simple and inexpensive form of Heliostat. (Read Sept. 17.) *Proceedings Am. Phil. Soc.*, vol. ii, pp. 97, 98.

1841. Observations on the effects of a thunderstorm which visited Princeton on the evening of the 14th of July, 1841. (Read Nov. 5.) *Proceedings Am. Phil. Soc.*, vol. ii, pp. 111–116.

1842. Résumé des Recherches faits sur les Courants d'Induction. *Archives de l'Électricité*, 1842, vol. ii, pp. 348–392.

1842. Contributions to Electricity and Magnetism. No. V. On Electro-dynamic Induction, and on the oscillatory discharge. (Read June 17.) *Proceedings Am. Phil. Soc.*, vol. ii, pp. 193–196.

1843. On Phosphorogenic Emanation. (Read May 26.) *Proceedings Am. Phil. Soc.*, vol. iii, pp. 38–44. Walker's *Electrical Magazine*, 1845, vol. i, pp. 444–450.

1843. On a new Method of determining the Velocity of Projectiles. (Read May 30.) *Proceedings Am. Phil. Soc.*, vol. iii, pp. 165–167. Walker's *Electrical Magazine*, 1845, vol. i, pp. 350–352.

1843. Nouvelles Expériences sur l'Induction développée par l'Electricité ordinaire. (Translated.) *Archives de l'Electricité*, 1843, vol. iii, pp. 484–488.

1843. On the application of Melloni's thermo electric apparatus to meteorological purposes. (Presented orally Nov. 3.) *Proceedings Am. Phil. Soc.*, vol. iv, p. 22.

Digitized by Google

1843. Theory of the discharge of the Leyden jar. (Presented Nov. 3.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 22, 23.

1844. On the Cohesion of Liquids. (Read April 5.) *Proceedings Am. Phil. Soc*, vol. iv, pp. 56, 57. Silliman's *Am. Jour. Sci.*, Oct., 1844, vol. xlviii, pp. 215, 216.

1844. On the Cohesion of Liquids,—continued. (Read May 17.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 84, 85. Silliman's *Am. Jour. Sci.*, Oct., 1844, vol. xlviii, pp. 216, 217. *L. E. D. Phil. Mag.*, June, 1845, vol. xxvi, pp. 541–543.

1844. Syllabus of Lectures on Physics. Princeton, 8vo, 1844. Republished in part in *Smithsonian Report*, 1856, pp. 187–220.

1844. Classification and Sources of Mechanical Power. (Read Dec. 20.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 127–129.

1845. On the Coast Survey. *Princeton Review*, April, 1845, vol. xvii, pp. 321–344.

1845. On the relative Radiation of Heat by the Solar Spots. (Read June 20.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 173–176. Brief Abstract in *Report Brit. Assoc.*, 1845, Part II, p. 6. Walker's *Electrical Magazine*, 1846, vol. ii, pp. 321–324. Froriep's *Neue Notizen*, etc., No. 826, 1846, vol. xxxviii, col. 179–182. Poggendorff's *Annalen der Physik und Chemie*, 1846, vol. lxviii, pp. 102–104.

1845. On the Capillarity of Metals. (Read June 20.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 176–178. Froriep's *Neue Notizen*, etc., No. 855, 1846, vol. xxxviii, col. 167–169. Poggendorff's *Annalen der Physik und Chemie.* 2d supplemental vol. (Nach Band lxxii), 1848, pp. 358-361.

1845. On the Protection of Buildings from Lightning. (Read June 20.) *Proceedings Am. Phil. Soc.*, vol. iv, p. 179. Silliman's *Am. Jour. Sci.*, 1846, vol. ii, pp. 405, 406. Walker's *Electrical Magazine*, 1846, vol. ii, pp. 324-326. Froriep's *Neue Notizen*, etc., No. 823, 1846, vol. xxxviii, col. 133, 134.

1845. An account of peculiar effects on a house struck by lightning. (Read June 20.) *Proceedings Am. Phil. Soc.*, vol. iv, p. 180,

1845. On Color Blindness. *Princeton Review*, July, 1845, vol. xvii, pp. 483-489. *Smithsonian Report*, 1877, pp. 196–200.

1845. On the discharge of electricity through a long wire, etc. (Read Nov. 7.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 208, 209.

1846. Repetition of Faraday's Experiment on the Polarization of Liquids under the influence of a galvanic current. (Read Jan. 16.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 229, 230.

1846. Extrait d'une Lettre à M. de la Rive, sur les Télégraphes Electriques dans les Etats-Unis de l'Amérique. *Biblioth. Universelle. Archives*, 1846, vol. ii, p. 178.

Digitized by Google

1846. Report on the action of Electricity on the Telegraph Wires, and Telegraph Poles struck by Lightning. (Read June 19.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 260–268.. Silliman's *Am. Jour. Sci.*, 1847, vol. iii, pp. 25–32. *L. E. D. Phil. Mag.*, 1847, vol. xxx, pp. 186–194. *Agricultural Report*, Comm'r Pats., 1859, pp. 509–511.

1846. On the ball supported by a water jet; also experiments in regard to the "interference" of heat. (Read Oct. 16.) *Proceedings Am. Phil. Soc.*, vol. iv, p. 285.

1846. On the corpuscular hypothesis of the constitution of Matter. (Read Nov. 6.) *Proceedings Am. Phil. Soc.*, vol. iv, pp. 287–290.

1846. On the Height of Auroræ. (Read Dec. 3.) *Proceedings Am. Phil. Soc.*, vol. iv, p. 370.

1847. Programme of Organization of the Smithsonian Institution. (Presented to the Board of Regents, Dec. 8, 1847.) *Smithsonian Report*, 1847, pp. 120–132.

1847. Article on "Magnetism" for the Encyclopædia Americana. *Encycl. Amer.*, 1847, vol. xiv, pp. 412–426.

1848. On Heat—A Thermal Telescope. Silliman's *Am. Jour. Sci.*, Jan., 1848, vol. v, pp. 113, 114.

1848. Explanations and Illustrations of the Plan of the Smithsonian Institution. Silliman's *Am. Jour. Sci.*, Nov., 1848, vol. vi, pp. 305–317.

1849. On the Radiation of Heat. (Read Oct. 19.) *Proceedings Am. Phil. Soc.*, vol. v, p. 108.

1850. Analysis of the dynamic phenomena of the Leyden jar. *Proceedings Amer. Association*, Aug., 1850, pp. 377, 378.

1851. On the Limit of Perceptibility of a direct and reflected Sound. *Proceedings Amer. Association*, May, 1851, pp. 42, 43.

1851. On the Theory of the so-called Imponderables. *Proceedings Amer. Association*, August, 1851, pp. 84–91.

1853. Address before the Metropolitan Mechanics' Institute, Washington. (Delivered March 19.) 8vo, Washington, 1853, 19 pp.

1854. Meteorological Tables of mean diurnal variations, etc.—Prepared as an Appendix to Mr. Russell's Lectures on Meteorology. *Smithsonian Report* for 1854, pp. 215–223.

1854. Thoughts on Education; an Introductory Discourse before the Association for the Advancement of Education. (Delivered Dec. 28.) *Proceedings Assoc. Adv. Education*, 4th session, 1854, pp. 17–31. *Amer. Jour. of Education*, August, 1855, vol. i, pp. 17–31.

1855. On the mode of Testing Building Materials, etc. *Proceedings Am. Assoc.*, August, 1855, pp. 102–112. Silliman's *Am. Jour. Sci.*, July, 1856, vol. xxii, pp. 30–38. *Smithsonian Report*, 1856, pp. 303–310.

Digitized by Google

1855. On the effect of mingling Radiating Substances with Combustible Materials (or incombustible bodies with fuel). *Proceedings Am. Assoc.*, August, 1855, pp. 112–116.

1855. Account of Experiments on the alleged spontaneous separation of Alcohol and Water. *Proceed. Am. Assoc.*, August, 1855, pp. 140–144.

1855. On the Induction of Electrical Currents. (Read Sept. 11.) *Proceedings Am. Academy of Arts*, etc., vol. iii, p. 198.

1855. Note on the Gyroscope. Appendix to Lecture by Professor E. S. Snell. *Smithsonian Report*, 1855, p. 190.

1855. Remarks on Rainfall at varying elevations. *Smithsonian Report*, 1855, pp. 213, 214.

1855. Directions for Meteorological Observations. (In conjunction with Professor A. Guyot.) *Smithsonian Report*, 1855, pp. 215–244.

1855. Circular of Inquiries relative to Earthquakes. *Smithsonian Report*, 1855, p. 245.

1855. Instructions for Observations of the Aurora. *Smithsonian Report*, 1855, pp. 247–250.

1855. On Green's Standard Barometer for the Smithsonian Institution. *Smithsonian Report*, 1855, pp. 251–258.

1855. Circular of Instructions on Registering the periodical phenomena of animal and vegetable life. *Smithsonian Report*, 1855, pp. 259–263.

1855. Meteorology in its connection with Agriculture, Part I. *Agricultural Report* of Comm'r Pats., 1855, pp. 357–394.

1856. On Acoustics applied to Public Buildings. *Proceedings Am. Assoc.*, August, 1856, pp. 119–135. *Smithsonian Report*, 1856, pp. 221–234. *Canadian Journal*, etc., March, 1857, vol. ii, n. s., pp. 130–140.

1856. Account of a large Sulphuric-acid Barometer in the Hall of the Smithsonian Institution Building. *Proceedings Am. Assoc.*, August, 1856, pp. 135–138.

1856. Meteorology in its connection with Agriculture, Part II. General Atmospheric Conditions. *Agricultural Report* of Comm'r Pats., 1856, pp. 455–492.

1857. Communication to the Board of Regents of the Smithsonian Institution, relative to a Publication by Professor Morse. *Smithsonian Report*, 1857, pp. 85–88.

1857. Statement in relation to the history of the Electro-magnetic Telegraph. *Smithsonian Report*, 1857, pp. 99–106.

1857. Meteorology in its connection with Agriculture, Part III. Terrestrial Physics, and Temperature. *Agricultural Report* of Comm'r Pats., 1857, pp. 419–506.

1858. Meteorology in its connection with Agriculture, Part IV. Atmospheric Vapor, and Currents. *Agricultural Report* of Comm'r Pats., 1858, pp. 429–493.

Digitized by Google

1859. On Meteorology. *Canadian Naturalist and Geologist*, August, 1859, vol. iv, pp. 289–291.

1859. Application of the Telegraph to the Prediction of Changes of the Weather. (Read August 9.) *Proceedings Am. Academy of Arts*, etc., vol. iv, pp. 271–275.

1859. Meteorology in its connection with Agriculture, Part V. Atmospheric Electricity. *Agricultural Report* of Comm'r Pats., 1859, pp. 461–508.

1859. On the Protection of Buildings from the effects of Lightning. *Agricult. Report*, Com. Pat., 1859, pp. 511-524.

1860. On the Conservation of Force. Silliman's *Am. Jour. Sci.*, July, 1860, vol. xxx, pp. 32–41.

1860. Circular to Officers of Hudson's Bay Company. (April 20.) *Smithsonian Miscell. Collections*, No. 137, vol. viii, pp. 1–4.

1860. Description of Smithsonian Anemometer. *Smithsonian Report*, 1860, pp. 414–416.

1861. Letter on Aeronautics to Mr. T. S. C. Lowe. (March 11.) *Smithsonian Report*, 1860, pp. 118, 119.

1861. Article on "Magnetism" for the American Cyclopædia. Edited by Ripley and Dana. *Am. Cycl.*, 1861, vol. xi, pp. 61–63.

1861. Article on "Meteorology" for the American Cyclopædia. Edited by Ripley and Dana. *Am. Cycl.*, 1861, vol. xi, pp. 414–420.

1862. Report of the Light-House Board on the proposed Transfer of the Lights to the Navy Department. Exec. Docts., 37th Cong., 2d sess., Senate Mis. Doc. No. 61, pp. 2–18.

1863. Letter to Orlando Meads, Chairman of Committee of Trustees, etc., on the semi-centennial celebration of the Albany Academy. (Dated June 23.) *Proceedings on Semi-Centennial Anniversary*, etc., pp. 66, 67.

1863. Introduction to Memoir by Professor J. Plateau. On the Figures of Equilibrium of a Liquid Mass., etc. *Smithsonian Report*, 1863, pp. 207, 208.

1864. On Materials for Combustion in Lamps of Light-houses. (Read Jan. 12, before the National Academy of Sciences.) [Not published in Proceedings.]

1865. Report relative to the Fire at the Smithsonian Institution, occurring Jan. 24, 1865. (In conjunction with Mayor Richard Wallach.) Presented to the Regents February, 1865. *Smithsonian Report*, 1864, pp. 117–120.

1865. Queries relative to Tornadoes: directions to observers. *Smithsonian Miscell. Collections*, No. 190, vol. x, pp. 1–4.

1865. Remarks on the Meteorology of the United States. *Smithsonian Report*, 1865, pp. 50–59.

1865. Remarks on Ventilation, especially with reference to the U. S. Capitol. *Smithsonian Report*, 1865, pp. 67, 68.

Digitized by Google

1866. Report on the Warming and Ventilating of the U. S. Capitol. (May 4.) *Exec. Doc.* No. 100, H. of Rep., 39th Cong., 1st sess., pp. 4–6.

1866. Report of Building Committee on Repairs to Sm. Inst. Building from Fire. (In conjunction with Gen'l Richard Delafield and Mayor Richard Wallach.) Presented to Regents April 28. *Smithsonian Report*, 1865, pp. 111–114.

1866. On the aboriginal Migration of the American races. Appendix to paper by F. Von Hellwald. *Smithsonian Report*, 1865, pp. 344, 345.

1866. Remarks on Vitality. *Smithsonian Report*, 1866, pp. 386–388.

1866. Meteorological Notes. To Correspondents. *Smithsonian Report*, 1866, pp. 403–412.

1866. Investigations in regard to Sound. (Read August 10, before the National Academy of Sciences.) [Not published in Proceedings.]

1867. Circular relating to Collections in Archæology and Ethnology. (Jan. 15.) *Smithsonian Miscell. Collections*, No. 205, vol. viii, pp. 1, 2.

1867. Circular relative to Exchanges. (May 16.) *Smithsonian Report*, 1867, p. 71.

1867. Suggestions relative to Objects of Scientific Investigation in Russian America. (May 27.) *Smithsonian Miscell. Collections*, No. 207, vol. viii, pp. 1–7.

1867. Notice of Peltier. *Smithsonian Report*, 1867, p. 158.

1867. Notes on Atmospheric Electricity. To correspondents. *Smithsonian Report*, 1867, pp. 320–323.

1867. On the Penetration of Sound. (Read Jan. 24, before the National Academy of Sciences. [Not published in Proceedings.]

1868. Appendix to a Notice of Schœnbein. *Smithsonian Report*, 1868, pp. 189–192.

1868. On the Rainfall of the United States. (Read August 25, before the National Academy of Sciences.) [Not published in Proceedings.]

1869. Memoir of Alexander Dallas Bache. (Read April 16.) *Biographical Memoirs of Nat. Acad. Sci.*, vol. i, pp. 181–212. *Smithsonian Report*, 1870, pp. 91–116.

1870. Letter on a Physical Observatory. (Dec. 29.) *Smithsonian Report*, 1870, pp. 141–144.

1871. Observations on the Rainfall of the United States. *Proceedings California Academy of Sciences*, vol. iv, p. 185.

1871. Instructions for Observations of Thunder Storms. *Smithsonian Miscell. Collections*, No. 235, vol. x, p. 1.

1871. Circular relative to Heights. For a topographic chart of N. America. *Smithsonian Miscell. Collections*, No. 236, vol. x, p. 1.

1871. Directions for constructing Lightning Rods. *Smithsonian Miscell. Collections*, No. 237, vol. x, pp. 1–3. Silliman's *Am. Jour. Sci.*, Nov., 1871, vol. ii, pp. 344–346.

Digitized by Google

1871. Letter to Capt. C. F. Hall, in regard to the Scientific Operations of the Expedition toward the North Pole. (June 9.) *Smithsonian Report*, 1871, pp. 364–366.

1871. Suggestions as to Meteorological Observations, during the Expedition toward the North Pole. *Smithsonian Report*, 1871, pp. 372–379.

1871. Meteorological Notes and Remarks. *Smithsonian Report*, 1871, pp. 452, 455, 456, 459, 461.

1871. Effect of the Moon on the Weather. *Smithsonian Report*, 1871, pp. 460, 461.

1871. Anniversary Address as President of the Philosophical Society of Washington. (Delivered Nov. 18.) *Bulletin Phil. Soc. Washington*, vol. i, pp. 5–14.

1872. Remarks on Cosmical Theories of Electricity and Magnetism: an Appendix to a Memoir by Professor G. B. Donati. *Smithsonian Report*, 1872, pp., 307–309.

1872. On certain Abnormal Phenomena of Sound, in connection with Fog Signals. (Read Dec. 11.) *Bulletin Phil. Soc. Washington*, vol. i, p. 65, and Appendix ix, 8 pp.

1873. Letter to John C. Green, Esq., of New York, on his establishment of the "Henry Chair of Physics" in the College of New Jersey. *Washington Daily Chronicle*, March 21, 1873.

1873. On Telegraphic Announcements of Astronomical Discoveries. (May.) *Smithsonian Miscell. Collections*, No. 263, vol. xii, pp. 1–4.

1873. Remarks on the Light-House Service. *Report of Light-House Board*, 1873, pp. 3–7.

1874. Report of Investigations relative to Fog Signals, and certain abnormal phenomena of Sound. *Report of Light-House Board*, 1874. Appendix, pp. 83–117.

1874. Memoir of Joseph Saxton. (Read Oct. 4.) *Biographical Memoirs of Nat. Acad. Sci.*, vol. i, pp. 287–316.

1874. Remarks on Recent Earthquakes in North Carolina. *Smithsonian Report*, 1874, pp. 259, 260.

1875. Remarks on the Light-House Service. *Report of Light-House Board*, 1875, pp. 5–8.

1875. An account of investigations relative to Illuminating Materials. *Report of Light-House Board*, 1875. Appendix, pp. 86–103.

1875. Investigations relative to Sound. *Report of Light-House Board*, 1875. Appendix, pp. 104–126.

1875. On the Organization of Local Scientific Societies. *Smithsonian Report*, 1875, pp. 217–219.

1876. Article on "Fog," for Johnson's Universal Cyclopædia. Edited by Dr. Barnard. *J. Univ. Cycl.*, vol. ii, pp. 187, 188.

1876. Article on "Fog Signals" for Johnson's Universal Cyclopædia. Edited by Dr. Barnard. *J. Univ. Cycl.*, vol. ii, pp. 188–190.

Digitized by Google

1876. Article on "Hygrometry" for Johnson's Universal Cyclopædia. Edited by Dr. Barnard. *J. Univ. Cycl.*, vol. ii, pp. 1072–1074.

1876. Letter to Rev. S. B. Dod; on researches made at Princeton. (Dated Dec. 4.) *Princeton Memorial*, May 19, 1878, 8vo, N. Y., pp. 51–70.

1877. Article on "Lightning" for Johnson's Universal Cyclopædia. Edited by Dr. Barnard. *J. Univ. Cycl.*, vol. iii, pp. 32–36.

1877. Article on "Lightning-rods" for Johnson's Universal Cyclopædia. Edited by Dr. Barnard. *J. Univ. Cycl.*, vol iii, pp. 36, 37.

1877. Remarks on the Light-House Service. *Report of Light-House Board*, 1877, pp. 3–7.

1877. Report of Operations relative to Fog Signals. *Report of Light-House Board*, 1877. Appendix, pp. 61–72.

1877. Address before the Philosophical Society of Washington. *Bulletin Phil. Soc. Washington*, vol. ii, pp. 162–174.

1878. On Thunder Storms. (Letter, Oct. 13.) *Journal Am. Electrical Society*, 1878, vol. ii, pp. 37–44.

1878. Letter to Joseph Patterson, Esq., of Philadelphia, on the "Joseph Henry Fund." (Dated Jan. 10.) *Public Ledger and Transcript*, May 14, 1878. *The Press*, of Philadelphia, May 14, 1878.

1878. Report on the Ventilation of the Hall of the House of Representatives. (Jan. 26.) 45th Cong., 2d sess., H. R. Report No. 119, pp. 1–6.

1878. Report on the Use of the Polariscope in Saccharimetry. (Feb. 5.) Misc. Doc., 45th Cong., 2d sess., H. R.

1878. Opening Address before the National Academy of Sciences. (Read April 16.) *Proceedings Nat. Acad. Sci.*, vol. i, part 2, pp. 127, 128.

1878. Closing Address before the National Academy of Sciences. (Read April 19.) *Proceedings Nat. Acad. Sci.*, vol. i, part 2, pp. 129, 130.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Gaylord Bros.
Makers
Syracuse, N. Y.
PAT. JAN. 21, 1908

3 2044

Digitized by Google

Digitized by Google